The comparison of large and small quantities of different orders of magnitude contains the staple of many of the most important applications of Mathematical Analysis; the Lunar and Planetary Theories depending almost entirely upon such considerations of relative magnitude.

The habit of looking towards an infinite distance, and discussing what takes place there, will render less startling a multitude of conceptions having in them a tendency to produce a feeling of vagueness, such, for instance, as the treatment of the mechanical effect of a couple as synonymous with that of an infinitely small force acting at an infinitely great distance.

As an important point, I would mention the tentative character of the inverse problem in which the form of a curve being given, its equation is to be investigated; the kind of uncertainty which will remain on the mind on account of defective estimation of magnitudes; and the necessity of a selection of what may appear the best of many possible solutions; all this will prepare the student for disappointment which, having perhaps a wrong notion of what is meant by calling mathematics an exact science, he will feel in the conflict of theories by which it is attempted to reconcile the results of experiment in such subjects as Heat, Light, Electricity, and Molecular action generally; for an instance of this I may refer to the battle of philosophers about the direction of vibration of the ether in Plane Polarization."

Contents—Chapter I: Introductory theorems; definitions; tracing by points; symmetry, 1–8. II: Orders of small quantities; forms of parabolic curves near the origin; cusps; tangents to curves; curvature, 9–19. III: Forms of parabolic curves at an infinite distance; examples of tracing curves; trigonometrical curves; illustrations of theory of equations; rules for approximation, 20–37. IV: Forms of curves in the neighbourhood of the origin; simple tangents; direction and amount of curvature; multiple points of two branches; curvature of branches at multiple points; multiple points of higher orders, 38–57. V: Forms of branches whose tangents at the origin are the coördinate axes, 58–67. VI: Asymptotes; points of intersection at an infinite distance; asymptotes parallel to the axes, 68–87. VII: Asymptotes not parallel to the axes; asymptotes to homogeneous curves, 88–106. VIII: Curvilinear asymptotes, 107–116. IX: The analytical triangle [Newton's parallelogram and De Gua's triangle]; properties of the analytical triangle, 117–132. X: Singular points; division into compartments; special curve of the fourth degree, 133–166. XI: Systematic tracing of curves; repeating curves, 167–185. XII: Inverse process; determination of the equation of a given curve, 186–202.

Matrices and Determinoids. By C. E. CULLIS. Cambridge: at the University Press. Royal 8vo. Volume 1, 1913; 12 + 430 pp. Price 21 shillings. Volume 2, 1918; 24 + 555 pp. Price 42 shillings.

Extracts from prefaces: "The present work is an amplification of a course of lectures given for the University of Calcutta in the winter of 1909–10. Its chief feature is that it deals with rectangular matrices and determinoids as distinguished from square matrices and determinants, the determinoid of a rectangular matrix being related to it in the same way as a determinant is related to a square matrix. . . . The first volume contains the most fundamental portions of the theory, and concludes with the solution of any system of linear algebraic equations, which is treated as a special case of the solution of a matrix equation of the first degree. . . . The second volume contains those parts of the theory which naturally precede any investigation of the special properties of functional matrices, i. e., matrices whose elements are rational integral functions of a finite number of variables. It deals almost exclusively with matrices whose elements are constants, which may be arbitrary parameters, and with those transformations of such matrices which are classed as equigradent. It does not however contain all the properties of such matrices. There remain many properties which it will be more convenient to consider after a preliminary study of functional matrices. . . . The following is a list of the books which have had most influence on the work as a whole: Bôcher's *Introduction to Higher Algebra*, Heffter and Koehler's *Lehrbuch der Analytischen Geometrie*, Muth's *Elementarteiler*, Netto's *Vorlesungen über Algebra*, Veronese's *Fondamenti di geometria a piu dimensioni*, Whitehead's *Universal Algebra*. My indebtedness to these and other writers will be more easily recognized in those portions of the work, occurring chiefly in volume 3, which are interpolations in the original scheme." It is expected that the third volume will contain the completion of the theory and "applications to vector analysis and the theory of invariants. The complete exposition was in fact undertaken with a view to these last mentioned applications."

Contents—Volume 1, chapter I: Introduction of rectangular matrices and determinoids, pages 1–21; II: Affects of the elements and derived products of a matrix or determinoid, 22–54; III: Se-

quences and the affects of derived sequences, 55–85; IV: Affects of derived matrices and derived determinoids, 86–104; V: Expansions of a determinoid, 105–152; VI: Properties of a product formed by a chain of matrix factors, 153–208; VII: Determinoid of a product formed by a chain of matrix factors, 209–247; VIII: Matrices of minor determinants, 248–264; IX: Rank of a matrix and connections between the rows of a matrix, 265–298; X: Matrix equations of the first degree, 299–363; XI: Solution of any system of linear algebraic equations, 364–417; Index, 419–430—Volume 2, XII: Compound matrices, 1–36; XIII: Relations between the elements and minor determinants of a matrix, 37–106, 515–520; XIV: Some properties of square matrices, 107–164, 521–530; XV: Ranks of matrix products and matrix factors, 165–227; XVI: Equigradent transformations of a matrix whose elements are constants, 228–308; XVII: Some matrix equations of the second degree, 309–377; XVIII: The extravagances of matrices and of spacelets in homogeneous space, 378–462, 531–534; XIX: The paratomy and orthotomy of two matrices and of two spacelets of homogeneous space, 463–514; Index 535–555.

Graphical and Mechanical Computation. By J. LIPKA. New York, Wiley, 1918. 9 + 264 pp. + 2 scales in pocket. Price $4.00.

Contents—I: Scales and the slide rule, 1–19. II: Network of scales; charts for equations in two and three variables, 20–43. III–V: Nomographic or alignment charts, 44–119. VI: Empirical formulas—non-periodic curves, 120–169. VII: Empirical formulas—periodic curves, 170–208. VIII: Interpolation, 209–223. IX: Approximate integration and differentiation, 224–259.

Extract from the Preface—"This book embodies a course given by the writer for a number of years in the Mathematical Laboratory of the Massachusetts Institute of Technology. It is designed as an aid in the solution of a large number of problems which the engineer, as well as the student of engineering, meets in his work. . . .

"Engineers have recognized for a long time the value of graphical charts in lessening the labor of computation. Among the charts devised none are so rapidly constructed nor so easily read as the charts of the alignment or nomographic type—a type which has been most fully developed by Professor M. d'Ocagne of Paris. Chapters III, IV, and V aim to give a systematic development of the construction of alignment charts; the methods are fully illustrated by charts for a large number of well-known engineering formulas. It is the writer's hope that the simple mathematical treatment employed in these chapters will serve to make the engineering profession more widely acquainted with this time and labor-saving device.[1]

"Many formulas in the engineering sciences are empirical, and the value of many scientific and technical investigations is enhanced by the discovery of the laws connecting the results. . . . Chapter VII considers the case where the data are periodic, as in alternating currents and voltages, sound waves, etc. and gives numerical, graphical, and mechanical methods for determining the constants in the equation.

"When empirical formulas cannot be fitted to the experimental data, these data may still be efficiently handled for purposes of further computation,—interpolation, differentiation, and integration,—by the numerical, graphical, and mechanical methods developed in the last two chapters.

"Numerous illustrative examples are worked throughout the text, and a large number of exercises for the student is given at the end of each chapter. The additional charts at the back of the book will serve as an aid in the construction of alignment charts. Bibliographical references will be found in the footnotes.

"The writer . . . owes the idea of a Mathematical Laboratory to Professor E. T. Whittaker of the University of Edinburgh."

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[1] The second edition, revised and corrected, of D'Ocagne's *Calcul graphique et nomographie* (Paris, O. Doin, 1914), contains an interesting and extensive bibliography down to the year 1912 (pages 381–386). Among eighteenth century items are: (1) L. Pouchet, "Arithmétique linéaire" appendix to *Echelles graphiques des nouveaux poids, mesures*, Rouen, 1795; and (2) J. von Segner, "Methodus simplex et universalis omnes omnium æquationum radices detegendi," *Acad. Petrop. Novi Comment.*, tome 7, 1761. E. V. HUNTINGTON briefly discusses nomography on pages 178–185 of his *Handbook of mathematics for engineers* (1918) which is reprinted from L. S. Marks's *Mechanical Engineer's Handbook* (New York, 1916). For an application of nomography to the geological problem of finding faults, see "The faultless faultfinder" by W. S. Weeks and E. V. Huntington, *Engineering and Mining Journal*, August 15, 1914.